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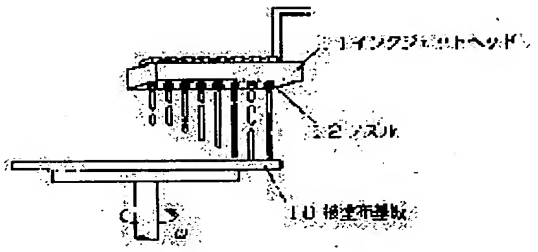
(54) THIN FILM FORMING METHOD

(57)Abstract:
PURPOSE: To reduce running costs and to process at a high speed in a thin film forming method in which a liquid substance is discharged from fine nozzles to be stuck on a substrate, and the substance is dried and cured.
CONSTITUTION: An ink jet head 11 having more than one fine liquid discharging nozzle 12 and a substrate 10 are rotated at the first relative velocity so that the surface of the substrate 10 is coated uniformly with a liquid to form the first coating state. Next, the head 11 and the substrate 10 are rotated at the second relative velocity which is larger than the first relative velocity to form a thin film in the second coating state which is more uniform than the first one by scattering off excessive liquid applied on the substrate in the first coating state.



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CLAIMS

[Claim(s)]

[Claim 1] The ink jet head which has two or more detailed nozzles for liquid regurgitation which carry out the regurgitation of the liquid, and the substrate which adheres to said liquid The spreading process which is rotated with the 1st relative velocity which is sufficient for adhering to said liquid on the front face of said substrate, applies said liquid to abbreviation homogeneity on the whole abbreviation surface of the front face of said substrate, and realizes the 1st spreading condition, It is made to rotate with the 2nd larger relative velocity than said 1st relative velocity after said spreading process. The thin film formation approach of having the process which forms the thin film which has the 2nd spreading condition that equalization of a spreading condition was made from said 1st spreading condition while dispersing the coating liquid object superfluously applied from said 1st spreading condition on said substrate.

[Claim 2] The thin film formation approach according to claim 1 that an ink jet head is an electrostatic suction mold ink jet head which makes a way attract and breathe out a liquid outside the nozzle for liquid regurgitation according to electrostatic force.

[Claim 3] The thin film [viscosity] formation approach according to claim 2 using the liquid of 50 or less cPs.

[Claim 4] The thin film formation approach according to claim 1 that an ink jet head is an ink jet head which differential pressure is impressed [head] to the meniscus formed in the nozzle for liquid regurgitation from a liquid source-of-supply side at the method of outside, and makes a liquid breathe out.

[Claim 5] Counter with the nozzle for liquid regurgitation, prepare the nozzle for air regurgitation, and airstream flows into the method of outside through the gap section of said nozzle for liquid regurgitation, and the nozzle for air regurgitation. The thin film formation approach according to claim 4 that a liquid rides on said airstream and is breathed out by the method of outside by setting up small the pneumatic pressure by

the side of said air regurgitation nozzle close attendants of said liquid regurgitation nozzle rather than the pneumatic pressure impressed to the meniscus formed in said nozzle for liquid regurgitation from a liquid source-of-supply side.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the approach of making dry and harden the liquefied matter which breathed out the liquefied matter from the minute nozzle, was made to adhere to a substrate about the thin film formation approach, and adhered, and forming a thin film (100 micrometers or less of thickness 10 micrometers or less being said to a wide sense generally.).

[0002]

[Description of the Prior Art] In recent years, the thin film technology is applied in various fields, and the approach of spin spreading, printing, a die coat, etc. is examined in addition to the approach which needs vacuum devices [like a spatter or vacuum evaporationo] whose formation approach of the is also.

[0003] Especially spin spreading is often used for resist spreading in a semi-conductor process, protective coat formation, etc.

[0004] Hereafter, the conventional spin coater (spin coater) is explained. Drawing 6 shows the process which forms a thin film using the conventional general spin coater, and is **.

[0005] As for a liquid and 107, in drawing 6 , the nozzle to which 101 carries out the regurgitation of the revolving shaft of a spin coater body and the liquid for [102] spreading in a sample fixed substrate and 103, the substrate for thin film formation in 104, and 105 and 106 are [a thin film and 108] scattering drops.

[0006] In such a configuration, as first shown in drawing 6 (a), a liquid 105 is put on a substrate 104 by the nozzle 103.

[0007] Subsequently, as shown in drawing 6 (b), a spin coater is rotated by the low-speed rotation omega 1, and a liquid 106 is familiarized with a substrate 104.

[0008] And it is made to rotate by the high-speed rotation omega 2, and a thin film 107

is made to form on a substrate 104, as shown in drawing 6 (c).

[0009]

[Problem(s) to be Solved by the Invention] However, with the above-mentioned conventional configuration, the scattering drop 108 which disperses and becomes useless will arise, and a result into which 80 - 90% of a liquid is thrown away will be brought as shown in drawing 6 (c).

[0010] About a liquid 105, if the amount regurgitation is not carried out, since a skip will be carried out to the bad part of concordance with a substrate 104 and a part will arise, this is because [being enough] a liquid 105 is breathed out so much.

[0011] Thus, in the conventional spin coater, it had the technical problem that the utilization ratio of a liquid will be bad and will make useless a great portion of coating liquid.

[0012] This invention solves the technical problem of the above-mentioned conventional technique, introduces a new liquid discharge head, and aims at offering the thin film formation approach that the use effectiveness of coating liquid is high.

[0013]

[Means for Solving the Problem] In order to attain this purpose, this invention the ink jet head which has two or more detailed nozzles for liquid regurgitation which carry out the regurgitation of the liquid, and the substrate which adheres to said liquid The spreading process which is rotated with the 1st relative velocity which is sufficient for adhering to said liquid on the front face of said substrate, applies said liquid to abbreviation homogeneity on the whole abbreviation surface of the front face of said substrate, and realizes the 1st spreading condition, It is made to rotate with the 2nd larger relative velocity than said 1st relative velocity after said spreading process. It is the thin film formation approach of having the process which forms the thin film which has the 2nd spreading condition that equalization of a spreading condition was made from said 1st spreading condition while dispersing the coating liquid object superfluously applied from said 1st spreading condition on said substrate.

[0014] And an ink jet head may be an electrostatic suction mold ink jet head which makes a way attract and breathe out a liquid outside the nozzle for liquid regurgitation according to electrostatic force, and viscosity can use the liquid of 50 or less cPs in this case.

[0015] Or an ink jet head impresses differential pressure to the meniscus formed in the nozzle for liquid regurgitation from a liquid source-of-supply side at the method of outside. You may be the ink jet head which makes a liquid breathe out. In this case Counter with the nozzle for liquid regurgitation, prepare the nozzle for air regurgitation,

and airstream flows into the method of outside through the gap section of said nozzle for liquid regurgitation, and the nozzle for air regurgitation. By setting up small the pneumatic pressure by the side of said air regurgitation nozzle close attendants of said liquid regurgitation nozzle rather than the pneumatic pressure impressed to the meniscus formed in said nozzle for liquid regurgitation from a liquid source-of-supply side, it is good also as a configuration a liquid rides on said airstream and is breathed out by whose method of outside.

[0016]

[Function] Thickness of coating liquid is made still more uniform, making coating liquid adhere on the whole abbreviation surface of the substrate by which relative rotation was beforehand carried out comparatively at the low speed using two or more regurgitation nozzles, making a high speed carry out relative rotation of the substrate more after that, and dispersing an unnecessary liquid by the above-mentioned configuration.

[0017] Therefore, the time amount which is controlled to the minimum and film formation takes the coating liquid which disperses and becomes useless is also shortened sharply.

[0018]

[Example] Hereafter, the example of this invention is explained to a detail, referring to a drawing.

[0019] (Example 1) The 1st example of this invention is explained hereafter.

[0020] Drawing 1 is an outline block diagram of a spin coater used for the thin film formation approach in one example of this invention.

[0021] In drawing 1 , 10 is a coated substrate, 11 is an ink jet head and 12 is a nozzle.

[0022] Here, the ink jet head 11 makes a liquid breathe out from a minute nozzle (usually 0.1mm or less), and says the thing which the discharge condition of a liquid is controlled [thing] by the electrical signal, and makes a liquid adhere to the recorded body with it.

[0023] Moreover, a nozzle 12 has more than one and is arranged by radial [of the rotating coated substrate 10] at fixed interval.

[0024] In such a configuration, the process which forms a thin film is explained hereafter. First, coating liquid is made to breathe out in the coated substrate 10 direction, and it is begun to make coating liquid adhere to the coated substrate 10 from the nozzle 12 of the ink jet head 11, carrying out low-speed rotation of the coated substrate 10.

[0025] and the coated substrate 10 top -- making coating liquid breathe out in the coated

substrate 10 direction from the nozzle 12 of the ink jet head 11 is continued, carrying out low-speed rotation of the coated substrate 10 until it makes coating liquid adhere to the whole surface mostly That is, this low speed rotation has just realized the rotational frequency which is sufficient for coating liquid adhering on the front face of the coated substrate 10.

[0026] Moving the ink jet head 11 to radial [of the coated substrate 10], multiple-times rotation of the coated substrate 10 is carried out by low-speed rotation, and coating liquid is made to adhere without a clearance throughout the front face of the coated substrate 10, in the pitch between two or more nozzles 12 is large, and Rhine of the coating liquid formed of the adjoining nozzle does not lap but estranging at this time.

[0027] Subsequently, mostly, after checking the thing on the coated substrate 10 which coating liquid adhered to the whole surface, while dispersing the coating liquid which was made to carry out high-speed rotation more nearly high-speed than previous low-speed rotation, and was superfluously applied in the coated substrate 10, the homogeneity of the spreading film is raised further and a thin film is formed on the coated substrate 10.

[0028] Conventionally, the regurgitation nozzle currently used for the spin coater can form the uniform and very thin film while becoming as [draw / by using the thing with a bore of 0.5-1mm, and using the ink jet head 11 like this example, although control of minute discharge quantity is difficult / a detailed pattern].

[0029] Furthermore, since coating liquid is beforehand applied all over the coated substrate 10 by the ink jet head 11 according to this example, there are few amounts of the coating liquid dispersed at the time of high-speed rotation, it ends, and a running cost can be reduced. The processing time is also sharply shortened by coincidence.

[0030] (Example 2) The 2nd example of this invention is explained hereafter.

[0031] Drawing 2 is the important section sectional view of a spin coater showing an example of the detail structure of the ink jet head used for the thin film formation approach in one example of this invention.

[0032] Although there are various methods in an ink jet recording method and there are generally Bubble Jet which generates air bubbles and makes a liquid breathe out by the pressure with heat energy, a piezo-electric mold method on demand which a liquid room is compressed [method] and makes a liquid breathe out by the pressure wave by the piezo-electric element, as for these methods, viscosity can use only very many [a limit of the liquid in which the regurgitation is possible / for example,] things of 1-5cP and a very small value.

[0033] If the ink jet head of a configuration of being called the electrostatic suction

method shown in drawing 2 on the other hand as compared with these methods is used, a hyperviscous (about 50 or less cPs) liquid can be made to breathe out comparatively.

[0034] In drawing 2 , it is made of the ink jet head of an electrostatic suction method, and 22 with a regurgitation nozzle in substrate standing ways, as for a coated substrate and 21, 23 is made of conductive matter like a metal, and 20 also has the role of an electrode.

[0035] And 24 is a high-voltage generating circuit and 25 is a liquid room. Thus, although the actuation is explained below about the constituted spin coater, the thin film formation actuation itself is theoretically [as an example 1] the same.

[0036] First, low-speed rotation of the coated substrate 20 is carried out, and a fixed period high-voltage pulse is impressed between the substrate standing ways 23 and the liquid room 25 by the high-voltage generating circuit 24.

[0037] While this high-pressure pulse is impressed, the meniscus of the liquid currently formed in the regurgitation nozzle 22 is attracted and breathed out in the direction of the substrate standing ways 23, and adheres on the coated substrate 20.

[0038] If the distance of the regurgitation nozzle 22 and the substrate standing ways 23 generally sets to 2-3mm, a liquid can be made to breathe out on the electrical potential difference of about 2-4kV.

[0039] It is about 50 or less cPs, the solution of a high insulating organic solvent can be applied, and polyimide liquid, resist liquid, etc. can be made to breathe out in such an electrostatic suction method ink jet.

[0040] Subsequently, mostly, after checking the thing on the coated substrate 20 which coating liquid adhered to the whole surface, while dispersing the coating liquid which was made to carry out high-speed rotation more nearly high-speed than previous low-speed rotation, and was superfluously applied in the coated substrate 20, the homogeneity of the spreading film is raised further and a thin film is formed on the coated substrate 20.

[0041] Also in this example, while becoming as [draw / a pattern more detailed than the conventional spin coater], the uniform and very thin film can be formed.

[0042] Furthermore, since coating liquid is beforehand applied all over the coated substrate 20 by the ink jet head 21 using electrostatic force, there are few amounts of the coating liquid dispersed at the time of high-speed rotation, it ends, a running cost can be reduced, and the processing time is also sharply shortened by coincidence.

[0043] (Example 3) The 3rd example of this invention is explained hereafter.

[0044] Drawing 3 is the important section sectional view of a spin coater showing an example of the detail structure of the ink jet head used for the thin film formation

approach in one example of this invention.

[0045] drawing 3 -- setting -- 30 -- an ink jet head and 31 -- for a pressure-regulator style and 34, as for an airstream inlet port and 36, liquid input and 35 are [the source of air supply, and 32 / a liquid pool and 33 / an air delivery and 37] deliveries.

[0046] The ink jet head 30 in this example uses airstream, on the other hand, the airstream from the source 31 of air supply is sent to a liquid pool 32, and impresses a constant pressure to the liquid in a liquid pool 32, and, on the other hand, is sent to the airstream inlet port 35 of the ink jet head 30 through the pressure-regulator style 33.

[0047] And the air which flowed in the head 30 from the airstream inlet port 35 flows out by the fixed rate of flow from the air delivery 36.

[0048] On the other hand, from the liquid input 34, the liquid in a liquid pool 32 flows in a head 30, and is led to a delivery 37.

[0049] Moreover, the pressure-regulator style 33 adjusts the air flow rate sent to a discharge head 30, and can take a configuration as shown in drawing 4 .

[0050] Drawing 4 shows the configuration which performs a passage change for the airstream from the source 31 of air supply with a solenoid valve 50.

[0051] In drawing 4 , by the normal state, although airstream flows Path A, if the signal of a regurgitation command is impressed at the time of the liquid regurgitation, the flow of air will change to Passage B.

[0052] Since the big passage resistor 51 of the pressure loss in passage like a throttle valve is formed in this passage B, the flow rate of the air which flows into the ink jet head 30 will decrease.

[0053] Next, drawing 5 shows the sectional view which expanded the air delivery 36 and about 37 delivery of the ink jet head 30.

[0054] Drawing 5 (a) shows the condition that a liquid does not carry out the regurgitation, the air pressure Pa near the outlet of the delivery 37 produced by the airstream sent to a head 30 is in the condition almost equal to the pressure Pi of the liquid produced with the pneumatic pressure impressed to the liquid pool, and the meniscus of a liquid is held in the delivery 37 at stability.

[0055] If the solenoid valve 40 shown by drawing 4 operates on the other hand and the flow of air changes from Path A to Path B, the air pressure near the delivery will fall to Pb like drawing 5 (b), the direction of the pressure of a liquid will become high, a meniscus will collapse, and the regurgitation of a liquid will be performed.

[0056] On the other hand, since airstream is still flowing out of the air delivery 36, the breathed-out liquid will be wrapped in this airstream, will pass through the air delivery 36, and will be breathed out by the method of outside.

[0057] Thus, the thin film formation actuation of the spin coater using the constituted ink jet head 30 itself is theoretically [as an example 1] the same.

[0058] Therefore, also in this example, although detailed explanation is omitted, while becoming as [draw / a pattern more detailed than the conventional spin coater], the uniform and very thin film can be formed.

[0059] Furthermore, since coating liquid is beforehand applied all over the coated substrate by the ink jet head 30 using electrostatic force, there are few amounts of the coating liquid dispersed at the time of high-speed rotation, it ends, a running cost can be reduced, and the processing time is also sharply shortened by coincidence.

[0060] In addition, since the ink jet head 30 used by this example is control by the solenoid valve 40, it has the field of being inferior to high-speed responsibility, but when there is no need of drawing a detailed pattern for the purpose of uniform thin film formation like this invention, it is satisfactory practically.

[0061] Furthermore, since the method of this example is simple pressure controlling expression, it cannot be easily influenced of the physical-properties value of liquids, such as viscosity, surface tension, and specific resistance, and also has the advantage that the degree of freedom of an applicable liquid is large.

[0062] Moreover, in the above example, although a coated substrate is arranged horizontally, a revolving shaft is set as vertical axes and the liquid is breathed out from the upper part, if formation of the thin film which has a desired property as a result is possible, not being restricted to such a configuration is undoubted.

[0063]

[Effect of the Invention] As mentioned above, since this invention can press down the liquid which obtains a uniform spreading thin film, disperses and is thrown away by making a high speed carry out relative rotation of the substrate more to the minimum after making coating liquid adhere all over the abbreviation for a substrate, making a low speed carry out relative rotation of the ink-jet head and the substrate which have two or more detailed nozzles comparatively, its running cost is cheap and it can offer the thin film formation approach which can moreover perform high-speed processing.

[0064] Furthermore, while becoming as [draw / by using an ink jet head / a detailed pattern], the more uniform and very thin film can be formed.

[0065] In this case, if an electrostatic suction method ink jet is used, it is about 50 or less cPs, the solution of a high insulating organic solvent can be applied, and polyimide liquid, resist liquid, etc. can be made to breathe out.

[0066] Moreover, if the ink jet using airstream is used, it is hard to be influenced of the physical-properties value of liquids, such as viscosity, surface tension, and specific

resistance, and has the effectiveness that the degree of freedom of an applicable liquid is large.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The outline block diagram of a spin coater used for the thin film formation approach in the 1st example of this invention

[Drawing 2] The sectional view showing the ink jet head of the thin film formation approach in this 2nd example

[Drawing 3] The sectional view showing the ink jet head of the thin film formation approach in this 3rd example

[Drawing 4] The block diagram showing the pressure-regulator style of the ink jet head of the thin film formation approach in this 3rd example

[Drawing 5] The sectional view showing the nozzle part of the ink jet head of the thin film formation approach in this 3rd example

[Drawing 6] The explanatory view of the conventional thin film formation approach

[Description of Notations]

10 Coated Substrate
11 Ink Jet Head
12 Nozzle
20 Coated Substrate
21 Ink Jet Head
22 Nozzle
23 Substrate Standing Ways
24 Electrical-Potential-Difference Generating Circuit
25 Liquid Room
30 Ink Jet Head
31 Ink Jet Head
32 Liquid Pool
33 Pressure-Regulator Style

34 Liquid Input
35 Airstream Inlet Port
36 Air Delivery
37 Delivery
40 Solenoid Valve
41 Passage Resistor
101 Revolving Shaft
102 Sample Fixed Substrate
103 Nozzle
104 Substrate
105 Liquid
106 Liquid
107 Thin Film
108 Scattering Drop

[Translation done.]